MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 2, 2015/2016

EOP 4086 - OPTICAL SIGNAL PROCESSING

(OPE)

11 MARCH 2016
9.00A.M-11.00 A.M.
(2 Hours)

INSTRUCTION TO STUDENT

1.This Question paper consists of 4 pages including cover page with 4 Questions only.

2.Attempt **FOUR** out of **FOUR** questions. All questions carry equal marks and the distribution of the marks for each question is given.

3 Please print all your answers in the answer Booklet provided.

Question 1

(a) Two spectral lines have wavelengths λ and $\lambda + d\lambda$ respectively. Show that if $d\lambda << \lambda$, the angular separation $d\theta$ in a grating spectrometer is given by $d\theta = \frac{d\lambda}{\sqrt{\left(\frac{e+d}{n}\right)^2 - \lambda^2}}$, where $(e+d)$ is the grating element spacing and n is the order at which the lines are observed.

[9 marks]

(b) The central circle of a zone plate has a radius of 0.07 cm. Light of wavelength $5000\,\overset{0}{\text{A}}$ coming from (i) an object at infinity, (ii) an object 147 cm away from plate falls on it.Find the position of the principal image in each case.

[6 marks]

(c) Find the radii of the first three transparent zones of a zone plate whose first focal length is one meter for $\lambda = 5893\,\overset{0}{\text{A}}$.

[5 marks]

(d) A zone plate is made such that the radii of the circles defining the zones are the the same as the radii of newton's rings formed between a plane surface and a surface whose radius of curvature is 150 cm.Find the primary focal length of the zone plate.

[5 marks]

Question 2

(a) Explain how the purity of a spectral line is related to the concept of temporal coherence. Show that the frequency spread of a spectral line is of the order of the inverse of the coherence time.

[10 marks]

(b) Light of $\lambda = 660nm$ has a wavetrains 40λ long, what are its coherence length and coherence time?

[5 marks]

Continued---

(c) (i) Establish the relation between coherence length and bandwidth

[4 marks]

(ii) Calculate the coherence length for CO_2 laser whose line width is 1×10^{-5} nm at IR emission wavelength of $10.6\mu m$.

[3 marks]

(d) Is strictly monochromatic light realizable practically?

[3 marks]

Question 3

(a) Describe one-dimensional Fourier transform with proper mathematical steps.

[12 marks]

(b) State and prove convolution theorem.

[7 marks]

(c) Determine the Fourier transform of the function $f(x) = A\cos k_0 x$.

[6 marks]

Question 4

(a) Suppose that as a theoretical limit 1 bit of information can be stored in each λ^3 of the volume hologram.At a wavelength of 492 nm and a refractive index of 1.30. Calculate the storage capacity of 1 mm^3 of the volume hologram.

[4 marks]

(b) The maximum spatial frequency f_{max} that can be resolved by a C CD camera is limited by their pixel dimensions, assuming a 100% fill factor.If the pixel size of the CCD camera is $8.4\mu m$ horizontally and $9.8\mu m$ vertically,calculate the maximum spatial frequency for horizontal and vertical direction.

[5 marks]

Continued---

(c) With the aid of a suitable diagram describe the Abbe's theory of image formation.

[12 marks]

(d) Write two important properties of hologram.

[4 marks]

End of paper